



Coal is a fossil fuel of sedimentary origin that has formed by coalification of vegetation over millions of years. Black coal consists of the higher rank anthracite, bituminous and sub-bituminous coals. The lower rank brown coal is sometimes known as lignite. In Australia coal deposits occur in all States and the Northern Territory and range from 15 million to 225 million years old.

Coal is primarily used as a fuel to generate electricity and in Australia is used to produce about 80% of the nation's electricity requirements. A special type of coal used to produce coke for the steel making process and by-products of coke-making include coal tar, ammonia, light oils and coal gas. Coal is used in cement manufacturing, food processing, paper manufacturing and alumina refineries.

Australia has 6 per cent of the world's black coal EDR and ranks sixth behind USA (31 per cent), Russia (21 per cent), China (13 per cent), India (8 per cent) and South Africa (7 per cent). Australia has about 25 per cent of world recoverable brown coal EDR and is ranked first. Australia is a major producer and exporter of coal and in 2008 accounted for about 6% of the world's black coal production and ranked fourth largest producer after China (45 per cent), USA (18 per cent) and India (8 per cent). Australia accounted for about 8 per cent of the world's brown coal production and ranked fifth largest producer after Germany (20 per cent), China (11 per cent), USA (9 per cent), Russia (9 per cent) and Greece (8 per cent).

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2013

Coal is:

- ✚ A sedimentary rock composed primarily of carbon
- ✚ Formed by decaying plant and animal matter under heat and pressure millions of years ago
- ✚ Formed as sub-bituminous coal, bituminous coal, or anthracite
- ✚ Known as having a bright, shiny lustre or can be very dull
- ✚ Pulverised and burnt to heat steam-generating boilers in power stations to generate electricity.
- ✚ Called steaming coal when used for electricity generation
- ✚ Called coking coal when it is used in furnaces to make steel.
- ✚ Is exported from Australia to countries overseas to use in electricity generation and the production of steel particularly in the Asian regions.

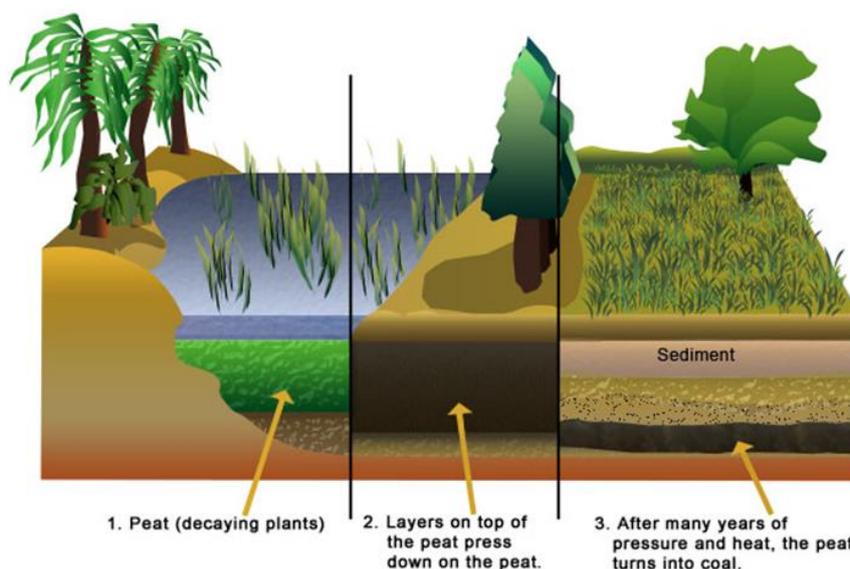


Diagram of how trees become coal.
Source: Library and Archives Canada
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How is coal mined?

In Australia, coal is mined by both open cut or surface mining and underground methods.

Open cut method:

In this type of mining the coal is reasonably close to the surface; no deeper than 120 metres.

The surface rock –overburden- covering the coal is blasted and removed by massive draglines with the topsoil being stored for use later in restoring the disturbed land to either natural woodlands or an alternative use e.g. for grazing purposes.

The uncovered coal is blasted to break up the layers and face shovels load the coal into large trucks which can hold up to 300 tonnes of material.

The coal is transported to the processing plant where impurities are removed.

After mining the land is rehabilitated. The pits or voids are progressively filled with the waste material, re-contoured and replanted with vegetation suitable to its post mining use. The final void is often reconstructed to form a lake or dam.



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Underground method:

Coal too deep to mine from the surface must be mined underground. Some coal is mined by the Bord and Pillar method where a continuous miner – a machine which continually cuts into the coal-cuts tunnels through the coal seams leaving pillars supported by roof bolts to hold up the roof.

Longwall mining uses a large cutting blade which slices across the coal layer to remove the coal seam. The coal is then transported to the surface on a conveyor belt. After the coal is mined the machine is dismantled and relocated to another section of the mine allowing the roof to collapse behind. Advances in technology have now introduced automated longwall mining mechanisms into the system.

How is coal processed?

Coal is crushed, screened and sorted according to customer requirements. It is washed to remove any pieces of waste rock that do not burn like shale. The coal then undergoes the froth flotation process where it is placed into tanks with liquids and reagents which assist in recovering more of the coal as it floats to the surface. The coal is then dewatered and left to dry out. It is then stored according to size and may be blended, again according to customer specifications. From there it is stockpiled or stored in bins ready for transport by road or rail.

What are the uses of coal?

There are two major types of coal, coking coal and thermal (or steaming) coal.

Coking coal is used to make coke, which is an ingredient in steel production. The steel is used in millions of items such as cars, trucks, fire engines, refrigerators and bridges, such as the Story Bridge and Sydney Harbour Bridge.

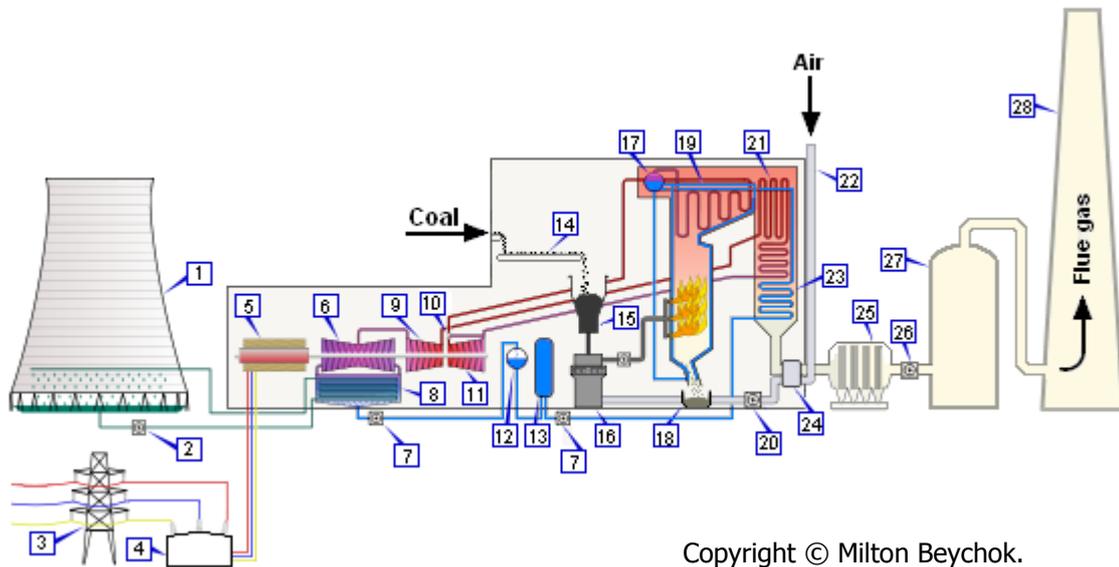
Thermal coal is used to provide heat energy. Its main use is in power stations where the heat is used to make steam, used to spin turbines and generate electricity.



Source: Oresome Resources 2011



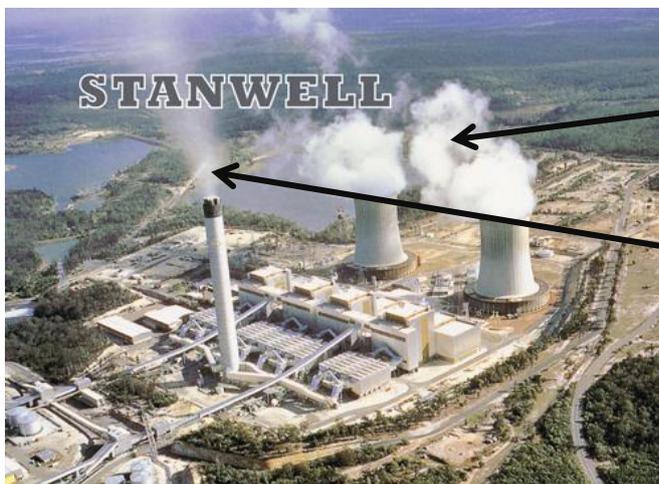
Generating Electricity from Coal



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Simplified coal-fired power plant

1. Cooling tower	11. High pressure steam turbine	20. Fan
2. Cooling water pump	12. De-aerator	21. Reheater
3. Three-phase transmission line	13. Feedwater heater	22. Combustion air intake
4. Step-up transformer	14. Coal conveyor	23. Economiser
5. Electrical generator	15. Coal hopper	24. Air preheater
6. Low pressure steam turbines	16. Coal pulverizer	25. Electrostatic precipitator
7. Condensate and feedwater pumps	17. Boiler steam drum	26. Fan
8. Surface condenser	18. Bottom ash hopper	27. Flue gas desulfurization scrubber
9. Intermediate pressure steam turbine	19. Superheater	28. Flue gas stack



Stanwell Power Station near Rockhampton Qld

Condensed water vapour from the cooling towers

Flue gases (Greenhouse emissions)



Pros	Cons
<p>Well Developed</p> <p>The technology we use to harness the energy in coal is well developed. The main reason for this is that fossil fuels have been used to power our world for many decades.</p> <p>Coal production doesn't require extensive secondary technologies to produce a useable fuel. Coal obtained directly from the mine is a very effective fuel for both the generation of electricity and in the manufacturing of steel.</p>	<p>Contribute to Global Warming</p> <p>Coal use in industry and power production is one of the major contributors to global warming by the industrial world. Both the heat from burning the coal and the greenhouse gases released during combustion are counted as major factors in the global warming crisis. According to the World Coal Association, Coal accounted for 25% of world greenhouse gas emissions in 2012.</p>
<p>Cheap and Reliable</p> <p>Coal and other fossil fuels are cheap and reliable sources of energy. They are excellent types of fuel to use for the energy base-load, as opposed to some of the more unreliable energy sources such as wind and solar.</p>	<p>Non-Renewable</p> <p>Fossil fuels are non-renewable energy sources. This means that there is a finite amount of fossil fuels available.</p> <p>However classifying coal as non-renewable is not entirely correct, as fossil fuels are products of millions of years of natural processes such as anaerobic decomposition of organic matter. In opposition to renewable energy sources such as wind and solar, it takes millions of years before the formation of fossil fuels takes place in any noteworthy quantities.</p>
<p>Safe and easy to store</p> <p>Coal is very stable and can be stored and transported safely. Oil, natural gas, hydrogen and other volatile fuels can be explosive and must be handled and stored carefully</p>	<p>Polluting chemicals that are dangerous for health</p> <p>Other toxins are released from the burning of coal that can be dangerous to the health of nearby populations. People with asthma are particularly sensitive to many of these pollutants.</p>
<p>New technologies allows greater use and application</p> <p>Powdered, gaseous and liquid coal products have been developed that burn cleaner and hotter than conventional coal. It is estimated that CO₂ emissions can be lowered another 5% by the use of low carbon technologies and much further still through carbon capture and storage techniques.</p>	<p>Environmental effects</p> <p>Coal mining techniques are often very damaging to the surrounding natural habitats. Strip mining is one of the most environmentally devastating mining procedures, is a common way of getting at coal deposits.</p> <p>Transportation of coal can be costly</p> <p>While coal can be transported safely, it is a very heavy and bulky load. Providing coal supplies to areas where coal is not available is very expensive. Much of the world's coal supply is moved over water, especially between large exporting countries like Australia to large importing countries like China.</p>



What is oxyfuel combustion?

Oxyfuel combustion is a low emission technology that aims to achieve near zero carbon dioxide or CO₂ emissions from the production of coal fired electricity.

Oxyfuel combustion burns the coal in almost pure oxygen rather than normal air producing a flue gas that is free of nitrogen and mainly made up of water vapour and CO₂.

This makes carbon capture easier because there is much less flue gas and the concentration of CO₂ is much higher than a normal coal fired power station. The water vapour is removed by cooling and suppressing the flue gas.

The CO₂ that remains is then turned into a liquid for later transport and storage. Using the technique of geosequestration this liquid can then be sequestered, or permanently buried, in:

- ✦ Deep saline aquifers
- ✦ Depleted gas or oil reservoirs
- ✦ Deep unmineable coal seams and adjacent strata
- ✦ Other deep geological formations.

Oxyfuel Combustion and CO₂ Capture

The Callide Oxyfuel Project at Biloela Central Queensland aims will demonstrate the viability of integrating oxyfuel combustion with carbon capture and sequestration to achieve near-zero greenhouse gas emissions from coal-fired electricity generation.

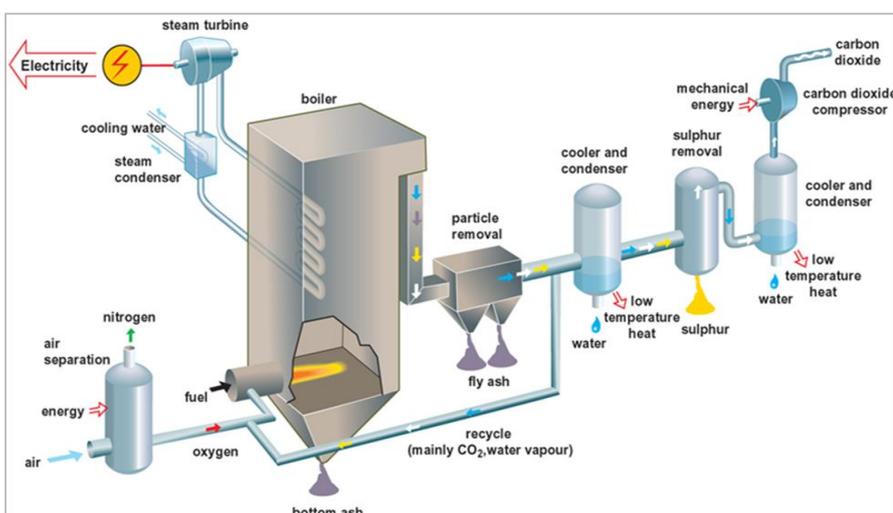
The project will retrofit oxyfuel technology to a boiler at the power station. The CO₂ once captured, will be purified and compressed to liquid form, ready for transport to an underground storage site.

What are the advantages?

- ✦ Potential to achieve near zero CO₂ emissions from the production of coal fired electricity.
- ✦ Burning coal in oxygen increases the volume of CO₂ captured.
- ✦ Process can be retrofitted to existing power stations and installed in new operations.
- ✦ Australia's low cost coal and gas can continue to be used for electricity generation.

What are the disadvantages?

- ✦ Technology has only been tested on a small or pilot scale to date. The technology needs to be proven on a commercial scale to prove large volumes of greenhouse gases can be managed.
- ✦ High cost of oxygen production and other plant equipment.
- ✦ Large amounts of energy required for process translating into higher volumes of fuel and increased energy costs.

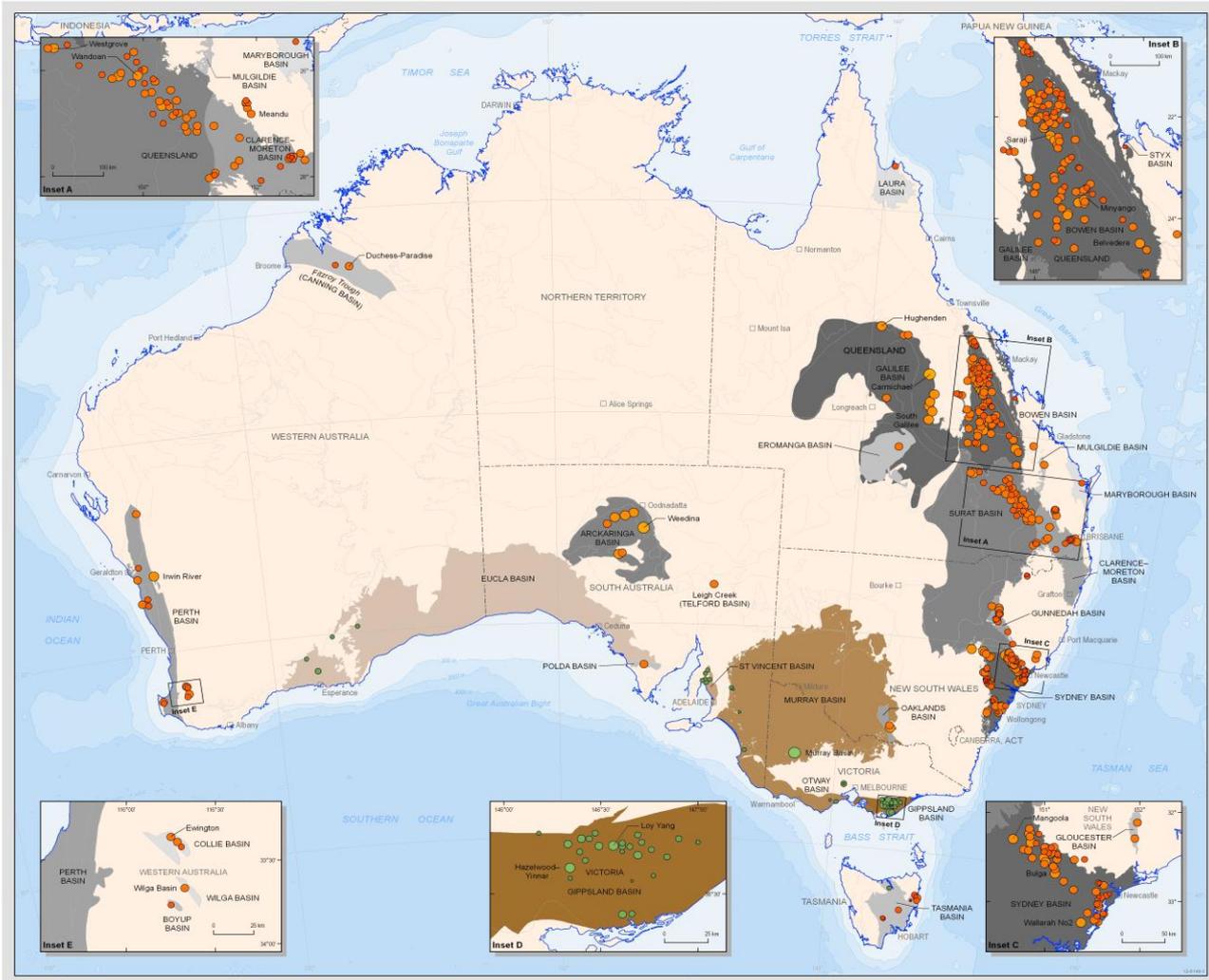


Source: Oresome Resources 2010

An animated version can be viewed at <http://www.newgencoal.com.au/oxyfuel.html>



ENERGY for the future



Online Resources

<http://www.ga.gov.au/energy/coal-resources.html>

<http://www.csiro.au/~media/CSIROau/Videos/Post-combustion%20capture/PCC.mp4>

http://www.oresomeresources.com/media/flash/interactives/coal_fired_power_station/

http://www.oresomeresources.com/media/flash/interactives/qld_resources_coal_energy_plant/

<http://www.newgencoal.com.au/oxyfuel.html>